

RESOURCE PARTITIONING AMONG WOODPECKERS  
IN NORTHEASTERN OREGON

A Dissertation

Presented in Partial Fulfillment of the Requirement for the  
Degree of Doctor of Philosophy  
Major in Wildlife Ecology

in the  
UNIVERSITY OF IDAHO GRADUATE SCHOOL  
by

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November 1980

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## NESTING

Woodpeckers nest in areas that provide foraging habitat. Trees selected for nest sites are: (1) of suitable size to contain a cavity at the appropriate height; (2) decayed enough to allow excavation; (3) situated to provide protection from predators or weather but accessibility to the woodpeckers.

Pileated woodpeckers excavate nests in dead ponderosa pine or western larch (Larix occidentalis) greater than 56 cm in diameter. These trees have been dead 10 or more years and consequently lack most bark, needles, limbs, or an intact top. Nest trees occur in grand fir forests with at least two canopy layers, high stem and snag densities, and a relatively closed canopy.

Pileated woodpeckers require large snags for a nest site because they excavate a cavity 50 cm deep and 25 cm wide, at an average height of 15 m. I presume nests are placed high in the tree to reduce nest predation as the cavity entrance is large enough for most mammalian predators (e.g., red squirrel, weasel, marten) to enter. Unlike most other woodpeckers, the pileated woodpecker is a strong excavator and often puts cavities in sound wood. If the selected nest tree leans, the entrance to the nest is generally on the underside. Cavities are below the top of the forest canopy because this location affords protection against the weather and avian predation. All woodpecker species position their nests there.

Williamson's sapsuckers generally nest in grand fir forest communities. These stands are probably preferred because Douglas-fir is favored for foraging. Sapsuckers nested in large diameter, live or recently dead ponderosa pine, western larch, and occasionally Douglas-fir

and grand fir. The primary difference between nest trees of the pileated woodpecker and Williamson's sapsucker is the tree's state of decay. The Williamson's sapsucker is a poor excavator and selects nest trees containing extensive decay. Many overmature trees in grand fir forests have broken tops through which decay has entered. Sapsuckers nest high in such trees where the wood is decayed and easily excavated. These trees are often partially alive or recently dead, and most bark, limbs, and needles are usually present.

Common flickers often nest in open ponderosa pine forests or along forest edges associated with grasslands in which they feed. Ponderosa pine comprises more than three-fourths of the nest trees, and most are snags. The common flicker is opportunistic and nests in a variety of tree conditions, heights, and locations. However, their inability to excavate effectively in sound wood and their relatively large cavity, restricts the number of snags suitable for nesting. Frequently they nest just below the point where the tree top has broken off. It is likely that decay weakens the tree and causes the break, or decay enters after the top breaks off. Trees larger than 50 cm in diameter accommodate nests at almost any height, while smaller diameter trees accommodate cavities only at low heights. Although common flickers nest anywhere from 1 to 23 m above ground, nest heights average 8 m. Low cavities are probably more vulnerable to predators than higher ones. This species occasionally uses existing cavities, reflecting its opportunistic nature.

Hairy and black-backed three-toed woodpeckers nest in similar trees and habitats and use open forests. Recently dead ponderosa and lodgepole pines serve most frequently as nest trees, although hairy

pine also has a thick sapwood layer but does not generally attain diameters large enough for all woodpecker cavities. In addition, their small size and thin bark, especially in the upper bole, encourage rapid drying that retards decay. Larger diameters and thicker bark near the base help retain moisture and encourage decay, frequently causing the tree to fall (Kimmey 1955). The thin sapwood and decay resistant heartwood of Douglas-fir and western larch discourage excavation. I assume woodpeckers rarely nest in dead grand fir because the wood deteriorates rapidly (Kimmey 1955, Wickman 1965a).

#### Pileated Woodpecker

Pileated woodpeckers nested almost exclusively in ponderosa pine and western larch snags (Fig. 2). One nest was found in a live grand fir. The characteristics of snags selected for nesting were significantly different ( $p \leq 0.01$ ) than expected by random choice (Appendix 1). Diameter at breast height (d.b.h.) and percent bark, broken top, and branches discriminated best ( $p \leq 0.01$ ) between snags used and not used for nesting (Appendix 2).

Pileated woodpeckers selected the largest dead trees available for nesting (Fig. 3). Nest tree d.b.h. and height averaged 76 cm and 28 m, respectively (Fig 4; Table 3). I think large trees were used because these woodpeckers excavated a large cavity (50 cm deep and 25 cm wide) at a mean height of 15 m. A tree greater than 56 cm d.b.h was required to contain the cavity that high in the tree. Physical conditions of the nest trees suggested nest trees had been dead 10 or more years. Fifty-eight percent of the nests occurred in snags with broken tops, with a mean of 12% broken off the top. Less than 25% of

Pileated woodpeckers can excavate a cavity in sound wood. Forty-two percent of 31 nests showed no evidence of decay in chips collected at the base of the tree. Only 19% of the nests had advanced decay, and decay was incipient or restricted to the sapwood in the remainder. Even though most of the nest trees had been dead at least 10 years, they showed little decay at the nest site.

In summary, pileated woodpeckers selected dead trees larger than 56 cm d.b.h. I think bark and limbs hindered the birds movement on trees, so those species retaining bark (i.e., Douglas-fir, grand fir) were seldom used. Ponderosa pine and western larch snags were preferred due to lack of bark, limbs, and decay conditions. I believe grand fir forest types were preferred because they offered higher densities of live, dead, and large diameter trees (Fig. 7) than the ponderosa pine types (Fig. 8). These sites offered large snags suitable for nesting and decadent trees and logs suitable for foraging. GBA (growth basal area) is the basal area at which crop trees (dominants) grow at 15 rings per 2.5 cm (Hall 1973). Hall (1973) found white fir (grand fir) sites more productive ( $GBA = 35 \text{ m}^2/\text{ha}$ ) than either ponderosa pine plant communities ( $GBA = 10 \text{ m}^2/\text{ha}$ ) or ponderosa pine - Douglas-fir plant communities ( $GBA = 22 \text{ m}^2/\text{ha}$ ).

My findings agree with those of McClelland (1977) and McClelland et al. (1979) who found pileated woodpeckers using broken-topped western larch snags in productive sites with an old-growth component. They reported a mean nest tree d.b.h. of 81 cm and a mean basal area of  $34 \text{ m}^2/\text{ha}$  which were similar to my findings. Conner (1973) and Conner and Adkisson (1976) reported smaller diameter, more decayed, and shorter nest trees being used in stands with a lower basal area



larger than 25 cm in diameter.

I suspect that most nests occurred in grand fir forest types because these stands provided large, decadent western larch and ponderosa pine suitable for nest sites. Live Douglas-fir trees were abundant here and provided a source of sap.

Jackman (1974) associated this species with dry, open coniferous woodlands, while McClelland (1977) found them restricted to larch and ponderosa forests. He suggested that nest placement is a function of the decay condition at the top of the tree. Raphael (1980) described Williamson's sapsuckers nesting in large diameter ( $\bar{x} = 82$  cm) trees in the early decay stages and occupying seven forest types.

#### Black-backed Three-toed Woodpecker

Sixty percent of the nests were in dead trees. Ponderosa pine and lodgepole pine were used exclusively (Fig. 2). Of the nests in snags, none of the tree and only four of the habitat characteristics were significantly different from the characteristics of available snags and habitat (Appendix 1). Generally speaking, nests occurred in small diameter ( $<50$  cm d.b.h.) (Fig. 3), tall ( $>15$  m), and recently dead ( $<5$  yrs) trees.

The ponderosa pine forest types contained 73% of the nest sites (Fig. 5). Nests occurred in stands with a mean canopy closure of 46% and basal area of  $20 \text{ m}^2/\text{ha}$ . More than three-fourths of the influence zones contained less than 5 stumps/0.1 ha, less than 10% log cover, and more than 5 snags/0.1 ha.

Jackman (1974) considered this species uncommon in the Blue Mountains and associated with ponderosa pine. This species was also uncommon in McClelland's (1977) study area where he located two nests



in Douglas-fir and western larch. He found nest cavities 2.5 m off the ground. Short (1974) considered this species characteristic of open areas with dead trees.

The preference for small diameter (<50 cm d.b.h.) trees was unusual as most woodpeckers used larger snags (Mannan 1977, Raphael and White 1978, Scott 1978, McClelland et al. 1979). McClelland et al. (1979) thought three-toed woodpeckers avoided drilling through the thick sapwood of large trees to get to the decayed heartwood. I question this theory because the smaller the tree, the greater the percentage of sapwood which decays more rapidly than heartwood. On Starkey I think this woodpecker prefers pine snags less than 50 cm d.b.h. because there is a thicker layer of sapwood than in other tree species of the same size and a higher percentage of sapwood than in trees greater than 50 cm d.b.h. Larger woodpeckers occasionally take over and enlarge nest holes of smaller species. If the smaller woodpeckers drill their cavities in trees too narrow to expand the cavity, they reduce competition for their nests (Short 1979). This species may be particularly vulnerable to competition because it is the only woodpecker I observed to lose its newly excavated cavity to competitors. I suspect the black-backed three-toed woodpecker prefers to nest low to the ground and uses those trees with the appropriate decay condition.

#### Northern Three-toed Woodpecker

I located only three nests of this uncommon species, all in lodgepole pine snags. The mean d.b.h. and height were 26 cm and 23 cm, respectively. The nest trees retained more than 75% of their bark, no needles, and 10 to 80% of the limbs. All tops were intact. These conditions indicated the trees had been dead 2 to 6 years.

bark beetle larvae are reported as prey (Beal 1911, Hoyt 1950, Conway 1957).

During this study pileated woodpeckers fed by excavating two-thirds of the time and scaling the remainder (Fig. 10). Tanner (1942) reported an almost identical distribution of foraging techniques (excavating - 72%, scaling - 23%). No other species excavated more than incidentally.

The pileated woodpecker excavated at all seasons but 71% occurred in the fall (Table 6). The majority (83%) of scaling occurred in the winter and spring (Table 6). Two-thirds of the excavation occurred in logs, while only standing trees (live and dead) were scaled. I suspect this segregation of foraging strategies by season occurred because winter snows buried the logs forcing the birds to forage on standing trees.

Solomon (1969) reported woodpecker predation on insect borers (obtained by excavation) during the winter. Hoyt (1957) concluded that ants and wood-boring beetle larvae were used during the winter months. However, both reports concerned deciduous forests where vegetable matter not available on Starkey was consumed during the fall. Further, snow did not limit access to logs during Solomon's study. These differences may have been a result of availability of food resources and environmental conditions.

I observed this species foraging in logs, live trees, and snags 36, 35, and 29% of the time, respectively (Fig. 11). The grand fir forest types were preferred and contained 64% of the feeding sites (Fig. 12).

Feeding sites were in dead and downed material with decay. The chi square analysis identified d.b.h., length, and tree species of foraging sites as significantly different from available dead and downed

material (Appendix 4). The discriminant analysis entered two variables (d.b.h., forest type) that distinguished foraging sites from available sites (Appendix 5). This woodpecker used Douglas-fir and western larch logs of large diameter ( $>25$  cm) and long lengths ( $>15$  m) disproportionately more than if selected at random. Seventy-eight percent of the downed material fed upon retained less than one-fourth of the bark, branches, and needles.

The chi square analysis identified the amount of remaining bark and branches and d.b.h. of snags at foraging sites as significantly different than if selected at random from available snags (Appendix 4). D.b.h. and forest type distinguished between used and available snags (Appendix 5). Snags greater than 50 cm d.b.h. with at least three-fourths of their bark but less than three-fourths of their branches characterized most (75%) of the feeding sites in dead trees. Snags retained an average of 12% of the needles (Fig. 13). These conditions suggested that trees dead only long enough to lose some limbs but not much bark were preferred feeding sites. The approximate time span since death was 5 years. Mannan (1977) also reported this species foraging on large diameter snags.

D.b.h. and height were significantly different between available live trees and those used for feeding. Percent bark discriminated best between feeding sites and available trees, because portions of the bark had been removed as a result of the foraging activity. Forty-six and 77% of the live trees used for feeding were greater than 50 cm d.b.h. (Fig. 14) and 15 m tall, respectively.

Because pileated woodpeckers foraged by excavation two-thirds of the time, they were probably feeding on carpenter ants. Sanders (1970)

found that carpenter ants only nested in logs, stumps, and snags greater than 30 cm in diameter and in live trees greater than 20 cm d.b.h. In Sanders' (1970) study of the available material greater than 30 cm in diameter, 48% of the logs and 37% of the stumps and snags were sound. Of available material 15 to 30 cm in diameter only 25% of the logs and 26% of the stumps and snags were sound. The smaller diameter material lacks permanence, decays faster, and forces the ants to move more often. I concluded that pileated woodpeckers selected woody material greater than 25 cm in diameter because prey (ants) was more abundant here. Larger diameter dead wood generally contains higher densities of woodborers due to surface area and moisture retention (B. E. Wickman, pers. commun.).

A third of pileated woodpecker foraging consisted of scaling, of which 79% occurred on live trees. I presume the woodpeckers were feeding on bark beetles in and under the bark.

The sexes exhibited different foraging behavior. Foraging sites of the females occurred more in (1) the ponderosa pine types (55%) and (2) snags and logs (83%); while the males used the grand fir types (84%) and live trees (56%) more than the females (Table 7). This segregation could reduce competition between the sexes if food was limiting. The male weighs 13% more than the female and may be better adapted to foraging in different material. In contrast, Kilham (1976) observed no differences in foraging habits between sexes.

#### Black-backed Three-toed Woodpecker

The next strongest excavator is the black-backed three-toed woodpecker (Lucas 1895). This species possesses a bill developed for pecking and a barbed tongue used to stab and retrieve beetle larvae.

Table 7. Differential foraging behavior between the sexes of five woodpecker species. Only those variables with significant differences ( $p < 0.01$ ) show the percentage of foraging sites in each category by sex.

Characteristic	Pileated Woodpecker		Black-backed Three-toed Woodpecker		Hairy Woodpecker		White-headed Woodpecker		Williamson's Sapsucker	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Forest type										
Open ponderosa pine									4	69
Ponderosa pine - Douglas-fir	16	55							38	14
Grand fir	84	45							57	17
Land form										
Ridge										
Slope										
Draw										
Condition										
Live	56	18	39	62						
Snag	13	43	61	38						
Log	31	40								
Stump	-	-								
Tree species										
Ponderosa pine			42	33						
Douglas-fir			10	11						
Lodgepole pine			27	53						
Grand fir			-	-						
Western larch			21	4						
DBH										
50 cm			72	91						
50 cm			28	9						
Location										
Trunk					96	61	83	100		
Branch					4	39	17	-		
Activity										
Excavate					4	-				
Scale			50	68	67	62				
Peck			31	32	15	28				
Glean			19	-	10	5				
Cones					3	5				
Sap										
Ground										
Sample size	32	40	54	72	203	21	72	69	94	36

The larvae of wood-boring beetles make up three-quarters of their food (Bent 1964). Wickman (1965b) and Baldwin (1960) reported this species feeding on woodborers (Monochamus oregonensis) and Engelmann spruce beetles (Dendroctonus engelmanni), respectively. Although other investigators reported that the black-backed three-toed woodpecker excavated for insects (Wickman 1965b, Short 1974), I did not observe this behavior. This species scaled 72% of the time and pecked and gleaned the remainder (Fig. 10). I expected this species to excavate, but the abundance of mountain pine beetles easily acquired by scaling or pecking may have precluded any other foraging strategy. There were no seasonal differences in their foraging techniques (Table 6).

All forest types were used with no strong preferences for any one type (Fig. 12). Ninety-seven percent of the foraging occurred on the ridges. Live and dead trees were used in approximately equal proportions (Fig. 11).

Tree species of foraging sites in live trees was significantly different than if selected at random (Appendix 4). Tree species was the variable best able to discriminate between live trees used and not used (Appendix 5). This woodpecker preferred and used lodgepole pine 54% of the time, presumably because many trees were infested with the mountain pine beetle (Table 1).

In dead trees used for feeding, d.b.h., height, and percent needles were significantly different from those of available snags (Appendix 4). Percent needles best discriminated between used and available snags (Appendix 5). This species fed in trees averaging 34 cm d.b.h., 19 m tall, and retaining 41% of their needles. The retention of needles suggested that the trees had been dead less than

2 years and would harbor emerging mountain pine beetles, woodborers, and other insects.

Tree condition, d.b.h., and species at foraging sites were significantly different between the sexes. Feeding sites of males were in dead trees (61%), had a mean diameter of 38 cm, and occurred primarily (42%) in ponderosa pine. Females foraged in live trees 38% of the time, in lodgepole pine 53% of the time, and in trees with an average d.b.h. of 25 cm. I believe the females were using smaller diameter trees because their bills are 7% shorter than the males (Jackman 1974) and scaling through the thin bark of smaller trees required less force. Bark was also thinner on limbs and higher up the trunk, but both sexes foraged on the trunk and at the same heights, so they apparently did not partition in this manner.

#### Northern Three-toed woodpecker

This species acquired food by scaling exclusively (Fig. 10). Northern three-toed woodpeckers feed on tree borers and bark beetles (Koplin and Baldwin 1970, Hogstad 1977). Seventy-eight percent of the feeding sites were in snags (Fig. 11).

All characteristics of foraging sites except bark condition were significantly different than if selected at random from available snags (Appendix 4). Forest type and percent needles were the best discriminators of habitat used and not used (Appendix 5). Northern three-toed woodpeckers scaled snags that averaged 24 cm d.b.h. and 18 m tall and retained most of their bark (93%), limbs (76%), and a portion of the needles (21%; Fig. 13). These conditions describe trees that have been dead less than 3 years. Koplin (1969) also observed this species feeding on insects in the bark of freshly killed trees. All